

White Paper Report

Report ID: 99897

Application Number: PF5003510

Project Director: John Childs (jchilds@historicnewengland.org)

Institution: Historic New England

Reporting Period: 7/1/2010-10/31/2010

Report Due: 1/31/2011

Date Submitted: 1/31/2011

Introduction

In June of 2010 Historic New England received a \$40,000 grant from the National Endowment for the Humanities (NEH) to support our project to develop a master plan for environmental improvements and energy conservation in our Collections and Conservation Center, an eight-story 120,000 square foot industrial building in Haverhill, Mass. In addition, NEH designated our project as one of its “We the People” projects. The goal of the “We the People” initiative is “to encourage and strengthen the teaching, study, and understanding of American history and culture through the support of projects that explore significant events and themes in our nation's history and culture and that advance knowledge of the principles that define America.” NEH determined that by better preserving the important collections housed in our Collections and Conservation Center, Historic New England will be contributing significantly to this effort. In the following pages, this white paper will briefly describe Historic New England and its collections, give a history of the environmental conditions at our collections storage facility and our efforts to improve them, and give a description and timeline of the project to develop a master plan. The recommendations of the master plan will be summarized, and conclusions and lessons learned for the project will be shared. Any views, findings, conclusions, or recommendations expressed in this white paper do not necessarily reflect those of the National Endowment for the Humanities.

Profile of Historic New England

Mission: We serve the public by preserving and presenting New England heritage -- “Historic New England is a museum of cultural history that collects and preserves buildings, landscapes, and objects dating from the seventeenth century to the present and uses them to keep history alive and to help people develop a deeper understanding and enjoyment of New England life and appreciation for its preservation.” (Mission statement in Strategic Plan, approved by Board of Trustees on May 12, 1999; revised October 13, 2003.)

Founded in 1910 as the Society for the Preservation of New England Antiquities, Historic New England celebrated its centennial anniversary in 2010. It is the oldest, largest, and most comprehensive regional preservation organization in the country, a leader in preservation, research, and innovative programming. As a museum of cultural heritage, Historic New England helps individuals and communities appreciate and preserve what has survived from the past, understand its relevance to their current lives, and make wise choices about their future. Extraordinarily diverse and well-documented holdings are collected and displayed to reflect the organization's overall mission.

Physical facilities include the organization's historic properties – thirty-six house museums and landscapes that span four centuries of architectural styles and five New England states, and the Collections and Conservation Center. The main library and archives collection are located at Historic New England's headquarters in the 1796 Otis House in Boston, Mass, one of the premier structures in Historic New England's collection of historic house museums.

Historic New England has a full-time professional staff of approximately 85, with an additional 130 part-time and seasonal staff. The annual operating budget for FY 2009 was \$9,925,000. In 2008, 160,000 people visited our properties. Almost 364,000 people visited off-site exhibitions organized by Historic New England using objects from collections storage and

library and archives. In that same year, 344 researchers, scholars and students visited collections in the Haverhill building; 970,000 users visited the website.

On September 30, 2005, the National Trust for Historic Preservation honored Historic New England with its Trustee Emeritus Award for Excellence in the Stewardship of Historic Sites, one of four top national awards given by the Trust. The award recognizes “that an institution’s skill and determination have given new meaning to its communities through preservation of architectural and cultural heritage.”

Collections Overview

Characterized by the American Association of Museums as “perhaps the most important collection in the nation for the documentation and interpretation of New England domestic architecture and life,” Historic New England offers a singular opportunity to experience the lives and stories of New Englanders. The organization’s collections comprise the largest assemblage of New England art and artifacts in the country, an extraordinarily broad collection of more than 110,000 objects of historical and aesthetic significance. These collections help people understand the region’s heritage through the possessions of those who lived here, and appreciate the ingenuity, craftsmanship, and style of the region. In addition, the Historic New England library and archives include more than one million items that document New England’s architectural and cultural history – photographs, architectural drawings, ephemera, manuscripts, family papers, and books.

Historic New England’s collections are distinctive in several respects. They reflect both the necessities and the luxuries of New England domestic life through four centuries. Thus, they complement and place in context the holdings of other institutions that collect primarily high-style examples of aesthetic workmanship and design. The collections are also remarkable for their degree of documentation. A high proportion of the objects come with histories and stories, making them culturally and historically rich resources for study.

Scholars, researchers and professional peers use Historic New England’s collections, library and archives on a regular basis. The Haverhill facility houses a significant portion of Historic New England’s holdings, and more will be moved there once improvements are made.

Historic New England is currently working to complete a new collections plan that will initiate a period of strategic acquisition and deaccession. The plan, which will be formally adopted in the new fiscal year, will emphasize that the organization will continue to collect individual objects relating to domestic life in New England from the 17th century to the present, with a particular emphasis on the 20th century. These objects will enter the study collection stored in the Collections and Conservation Center and will be used to complement and support the collections housed in the historic house museums. Continued acquisition will require that Historic New England provide storage facilities for these acquisitions within an environment able to provide long-term preservation. The environmental planning project for the Collections and Conservation Center building will allow the organization to prepare strategically for these new acquisitions.

Project Overview

Historic New England has recognized the importance of preventive conservation in the preservation of buildings and collections for more than thirty years, and has continually worked to improve conditions and collections-care practices during that time. In 1989 Historic New England moved its off-site storage facility from Salem, Mass. to the Lang building in Haverhill, and has since attempted many improvements to the environment in the building. Despite time and effort spent, environmental conditions in the storage facility have remained problematic, and the current systems are increasingly unsustainable in today's context of energy efficiency and "green" approaches to environmental control.

In 2006, Historic New England purchased the entire Lang building with plans to lease unoccupied space to other institutions for collections storage. Historic New England currently leases 9,000 square feet of storage facilities in the building to other cultural institutions and tenants. During the last decade Historic New England relocated 13 staff members to the Haverhill facility, established a conservation laboratory on the 8th floor, and significantly increased the square footage of storage space requiring humidification. Historic New England offers a number of public programs at the Collections and Conservation Center including curator led tours of the facility, workshops and staff trainings. The annual Program in New England Studies uses the collections and spaces in the Haverhill storage facility to teach the history of domestic life in New England. Historic New England's future plans include creating new spaces within the building for programming purposes, as well as additional storage facilities for lease to other cultural institutions and tenants. Implementation of environmental improvements to the building will allow for increased public programming and public access to our collections.

As part of the strategic agenda adopted in 2009 by the board of trustees, Historic New England's goals include "developing creative solutions to facility challenges, ...increasing the emphasis on general and contextual research to conduct and support scholarship related to our preservation work, maintenance of our buildings, landscapes and archaeological resources, and care and interpretation of collections...[and] collaborating with partner organizations to...promote and preserve New England cultural heritage." In addition, Historic New England will focus on "exploring methods to convert administrative and maintenance operations to more environmentally sustainable practices,...demonstrating our commitment to environmental sustainability by fully implementing available practices, ...[and] reducing energy use by improving the efficiency of our mechanical and utility systems."

The planning project to improve environmental conditions in the Haverhill facility used monitoring data for the building collected by Historic New England over its years of occupancy, concentrating on the most recent years. Historic New England brought together an interdisciplinary team of staff conservators, environmental engineers and architects from Building Science Corporation, and heating system consultants to inspect the building and current environmental systems, and use the collected data to evaluate the structure and make recommendations for overall improvements to the building's interior environment. Building Science Corporation submitted a written master plan for the building which identified a number of priorities. The plan recommended making immediate improvements to the current heating system to improve efficiency, and addressing issues of water infiltration through installation of flashing and repair or replacement of windows in all window openings. The extent of the water infiltration issues, and the need for re-flashing and repair or replacement of *all* the windows was

an unexpected result of the building inspection and evaluation. Next the plan recommended construction of interior insulated walls on individual floors that could be installed incrementally, floor by floor, as collections movement logistics allow and funds become available. At the same time, epoxy coatings should be applied to floor and ceiling concrete surfaces to control dust production. Current heat and humidification systems could remain in place initially, and be replaced in a phased approach with individual HVAC systems on each floor. These systems could be sized for the domestic market, and therefore more easily serviced by a wider range of maintenance service providers, thereby providing an efficiency benefit. Historic New England staff would be more easily able to manage service maintenance of smaller systems as well. Eventually all floors would be improved, and environmentally controlled and insulated spaces would be available for lease by other institutions for collections storage.

Outcomes of the planning project include: (1) Recommendations for immediate improvements which can be made to the heating system in place which will increase energy efficiency; (2) A specific plan for practical, cost-effective passive methods to improve environmental conditions for the various types of collections housed in the Haverhill building, using a phased approach; (3) recommendations for HVAC system improvements which would use environmentally sensitive, energy-efficient equipment that is widely available for the domestic, rather than commercial market, and therefore easily obtained, installed and serviced, and within the monitoring and maintenance capabilities of Historic New England staff. The planning project brought a holistic approach to evaluating the structure and systems of the collections storage building and its capabilities for more effective climate control and energy conservation, with each component of the proposed plan considered in relation to the others. (4) Project director John Childs is scheduled to discuss the project as part of a presentation on NEH planning grants at the American Association of Museums annual meeting in Houston, Texas in May, 2011.

Current Conditions

Environmental conditions in Historic New England's Collections and Conservation Center continue to be an issue despite longstanding efforts to manage them. Until the facility was purchased, Historic New England had little control over the building's main heating system. As adjustments were made to one parameter, other conditions were adversely affected. Now that Historic New England owns the building, it can make more comprehensive changes.

Historic New England currently occupies 65,000 square feet of the Haverhill building, and approximately 27,400 square feet are designed to be climate controlled, using heat pumps to provide heating and cooling, and electrode steam humidifiers to provide humidification. Windows in the collections storage areas have been covered to minimize light and provide some insulation. These spaces are also serviced by the building's main heat system, which uses steam heat from a central boiler and oil-fired furnace. The rest of the spaces are climate modified, meaning they have heat from the building's system, and some humidification. The conservation lab on the 8th floor is included in the climate controlled area. Air in the largest collections storage spaces is circulated using large wall-mounted industrial fans.

The majority of the environmental issues are related to operation of the heating system. The existing steam heat system is old and not designed to allow for different heat zones in the building, so some areas in the climate controlled zone become overheated. Also the original plan

was to maintain temperatures at 50° F during the winter. However, as collections storage has seen increased use by staff and outside researchers, maintaining such low temperatures is in conflict with human comfort. The heat drives the relative humidity to unacceptably low levels (below 20%) so additional humidification has been added. The humidifiers release moisture in the air, which has been known to activate the fire alarm. The added moisture often condenses on the un-insulated concrete exterior walls, resulting in mold growth. Additionally, particulate dust has been penetrating the windows or shedding from unsealed concrete surfaces to accumulate on objects.

Collections Storage

Currently the collections are stored using a variety of methods appropriate to the individual type of object. Furniture is stored on open shelving, textiles are stored in archival textile boxes stored on open shelving, or are hung on padded hangers in closed enameled steel cabinets. Silver is stored in closed steel cabinets, paintings are hung on steel grid panels, and small objects are stored on enclosed shelving. Framed paper objects are stored vertically on enclosed shelving with loose acid free dividers. Plans to improve storage methods will be implemented once the environment in the building has been improved.

History of the Project

As part of its mission to preserve its cultural history collections, Historic New England seeks to store its collections in environmental conditions appropriate to their type. During its first half-century, the organization's collections were available to visitors and scholars on a very limited basis. Historic New England's earliest days were devoted to accumulation rather than outreach. In the last thirty years, we have opened our collections to a larger public. Starting in 1978, Historic New England began to assemble its collections not related to specific properties in a single location. A comprehensive series of conservation surveys of the collections throughout Historic New England's properties carried out in the 1980's led to a decision that the study collection needed to be in a location where it could be better cared for and accessed by researchers and scholars. In 1989, the entire study collection was moved to 30,000 square feet in a newly renovated, Class I fireproof building in Haverhill, Mass.

The collections storage facility in Haverhill was initially housed on two floors (each approximately 15,000 square feet) with some climate-controlled or climate-modified zones using heat pumps and humidifiers. Climate-modified zones were supposed to use low-temperature set points to control the RH during the winter months, although the existing heating system in the building has had trouble allowing such low temperatures in these areas, while maintaining comfortable working temperatures on other floors in the building occupied by other tenants.

During the 1990's Historic New England leased additional space in the building, conducted conservation surveys of the collections, and made improvements to the storage materials and equipment used in collections storage. The conservation surveys identified improving the environment and storage conditions of the collections as a long-range goal. With the purchase of the Haverhill building in 2006, Historic New England was now in a position to undertake a comprehensive approach to controlling the environment using all available techniques. Failing humidifiers were replaced with newer technology, and target conditions were

adjusted to accept the reality of what was possible in the building, and in keeping with findings in the conservation literature during the previous decade suggesting permissible ranges of 40-60% RH.

In 2009 Historic New England applied to the National Endowment for the Humanities for a planning grant to develop a master plan to improve the environmental conditions and energy efficiency of the Haverhill building. Recent studies at the Image Permanence Institute, a leader in the field of museum environments, have reinforced the idea that a relative humidity range of 40% - 60%, seasonally adjusted, is acceptable for most collections types, and more easily achieved in a cost-effective and energy efficient way. These are the parameters that Historic New England has mandated for general collections storage, using cost-effective approaches such as humidistatic heating where possible. The plan was also to be flexible enough to include some spaces in the building capable of maintaining a narrower range of relative humidity for storage of more vulnerable collections, such as the glass-plate negative collection currently housed under inadequate conditions in the Otis House Library and Archives in Boston.

Planning Project Timeline

July, 2010 Historic New England conservator, John Childs, and team leader of collections, Julie Solz compiled historic energy use data for the facility for the last three years, including kWh and gallons of #4 heating oil used, in order to provide consultants Al Letelier of ACL Plumbing and Heating, Inc. and Building Science Corporation with baseline information on the current systems for use in the evaluation and planning process. John Childs compiled environmental conditions data from key collections storage locations, including the 3rd, 4th, 5th, 6th, 7th and 8th floors in the Haverhill building for the last two years.

August, 2010 Steam heating systems consultant Al Letelier visited the Collections and Conservation Center to evaluate the heating system throughout the building and make recommendations for improving the system's efficiency. After inspecting the system, Letelier found a number of issues. A run of over 150 feet in the main steam pipe in the basement is un-insulated. Fixing this is the simplest step to take that will have a positive effect on efficiency and heating bills. In addition, there are no vents at the top of the main risers in the building, so that the traps at the end of the radiating pipe runs do all the venting. Expansion joints in the radiating pipes are not all functioning, and the pipes have lost their proper pitch, causing bumping, condensation, and restricted steam flow, all decreasing the efficiency of the system. Finally, there is a condensate return pipe in the basement which rises over a walkway. This up-hill run in the condensate return requires that the entire system be run at a higher pressure than would otherwise be necessary. Letelier made a number of recommendations for improvements to the system efficiency which could be made immediately. They are:

Riser and Radiator Upgrades and Maintenance

1. Inventory of all radiator traps on each floor, including type and location (Can be done in-house).
2. Identify malfunctioning traps, repair or replace as necessary.
3. Install vents at the top of each heating system vertical riser.
4. Stock replacement traps in-house, institute regular inspection/repair program for traps one floor/year

5. Check radiation runs for proper pitch toward steam traps, and correct sags and malfunctioning expansion joints

Basement Main System Upgrades

1. Insulate steam main in basement (and risers where possible). Install small unit heaters in basement if necessary for human comfort in basement during winter.
2. Install condensate pump on condensate line that steps over walkway in front of elevator. This will allow lowering of steam pressure in entire system.
3. Lower steam pressure in system.
4. Install cycling controller on boiler which regulates boiler operation according to outside temperature.
5. Create system binder to be kept in basement that includes information on pressure settings, burner settings, recommended maintenance procedures, and maintenance log.

It is possible to convert the Cleaver-Brooks boiler in the building from #4 heating oil to natural gas, and the gas company performed an energy audit to determine if there would be efficiency or cost improvements to be gained from such a conversion. Victor Carta of National Grid performed the audit, and determined that the building has a heating index of approximately 0.21 therms/ft², which is considered efficient. This is probably due to the fact that part of the building is not heated to human comfort levels. Based on the energy audit, National Grid would only provide rebates for conversion to natural gas if Historic New England would sign a minimum usage agreement.

Kohta Ueno, building engineer from Building Science Corporation, made an initial visit to the Haverhill building, and John Childs gave him the environmental monitoring data, energy usage data, floor plans and elevations of the building, and the reports from ACL Consulting and Inspection Services and from National Grid. Ueno toured the building, including basement, roof and storage spaces. Ueno interviewed Childs to determine building usage needs and current problems identified by Historic New England staff. Experience during the spring of 2010 had emphasized the problems of water infiltration in the building, including leaking from center of ceilings on middle floors during and after rain storms.

September, 2010 Building Science Corporation scheduled three days of site visits. During these site visits they inspected the steam heating system for the building, as well as the Friedrich heat pumps and Nortec steam humidifiers on individual floors. They also inspected the rubber membrane on the flat roof and the freight and passenger elevator shaft cupolas. A sample window opening was dismantled, and it was determined that window openings which had had the sashes removed had been filled with exterior grade plywood on the exterior, ½ inch drywall on the interior, with fiberglass insulation between. Window openings which still had original sash on the collections storage floors had drywall on the inside, and the upper sash had metal sheet and fiberglass insulation between the sash and the drywall. It was determined that a complete inventory of current window opening treatments should be made. Using an Infra-Red camera and visual inspection water infiltration into the concrete of the building was analyzed, and it was determined that each floor had had a secondary concrete slab poured over the original slab. It was necessary to determine if water was penetrating the concrete on the exterior of the building, and if water was infiltrating between the slabs of each floor. Exterior and interior water

infiltration tests were conducted by spraying water on the exterior of the building between the 8th and 7th floors, and by pooling water above cracks in the floor on the 7th floor near where water had been leaking from the ceiling on the 6th floor. The results of these tests indicated that water was not penetrating the concrete of the building and flowing between the slabs of the floor, but was instead entering around the window openings and flowing over the floors to infiltrate between floors through cracks in the slabs. Controlling water infiltration would therefore be primarily a task of improving the flashing and seals around the window openings in the building.

October, 2010 After conducting their site visits and water infiltration testing, and using the information assembled and provided to them by John Childs, Building Science Corporation completed a master plan for the building based on this information and test results, and their experience with reinforced concrete buildings. The master plan includes an analysis of the building's performance in its current configuration, and a discussion of the various options for improving the performance by reducing water infiltration, increasing energy efficiency, and improving the stability of the temperature and relative humidity in the collections storage spaces. The master plan makes a number of recommendations, in a style of branching options. Although various options are explored, one route through the branching options is recommended. First, implement the recommendations made in the heating system report provided by ACL. Second, address the water infiltration issues by installing new flashing at all window openings, re-sealing or replacing current windows or window infills, and re-coating the exterior concrete with an appropriate sealer. Third, install secondary insulated interior walls in the collections storage areas. This would improve energy efficiency, and allow acceptable RH levels to be maintained more easily without problematic mold growth but would also result in an 11% reduction in available space in the storage areas. Fourth, install residential grade heat pumps, air handlers and ducting to condition the newly enclosed spaces to desirable levels. Steps three and four could be carried out incrementally, one floor at a time, and could be evaluated and modified during each phase of the installation.

Master Plan Conclusions & Recommendations

The master plan submitted by Building Science Corporation includes a summary of the overall conclusions and recommendations, which states:

It is acknowledged that this master plan will need to be a compromise between creating ideal conditions for the collection, improving energy efficiency, the aggregate cost of the measures, and incremental availability of funds. Assuming that interior and exterior insulation retrofit options are discarded (for the reasons stated in the report), a set of branching options is presented for this project.

Based on exploration of these branches, a top recommendation was chosen. First, the water leakage at windows needs to be addressed, and can reduce many of the durability concerns due to bulk rain leaks onto the collection.

Then, it seems that the lowest-cost, highest impact renovation plan would be to retain the steam system (with tuning) and build the "box within a box" enclosure at collection

spaces. The collection spaces (with window infill panel) would be the first candidate to try this plan; note that it could be done incrementally, thus providing feedback on the most cost-effective ways to deal with problems occurring during construction.

For space conditioning of the collection spaces, an air source heat pump will be the lowest first cost option; in addition, it eliminates the use of water piping connections to the air handler, except for a condensate drain for summertime cooling. However, given the concerns on heat pump cold weather performance, it would be most worthwhile to measure the unit's ability to maintain interior conditions and energy performance, before repeating the implementation.

Of course, if the central boiler is reaching its end of service life, a conversion to hydronic heating provides many benefits, including improved control over individual space temperatures, reduced energy use, and providing a readily available heating source for the "box within a box" spaces.

Next Steps

As Historic New England moves forward with plans to make improvements to the environment in its Collections and Conservation Center, the Facility/Energy Master Plan submitted by Building Science Corporation will be an invaluable guide to making decisions about implementation. One important factor affecting Historic New England's planning was outside the scope of BSC's mandate in developing the Master Plan. The Lang Building, built in 1911, is part of an historic district in Haverhill, Mass. As such, the current insulated window infills on the building are inappropriate, especially on a building belonging to a preservation organization such as Historic New England. If all the windows need to be addressed as part of a plan to improve the energy efficiency and environmental control in the building, then they should be treated in a way that is in keeping with the historic nature of the building. Decisions about the treatment of the windows will be made in consultation with the Massachusetts State Historic Preservation Officer (SHPO). In order to begin planning for a window retro-fit for the building, John Childs prepared a window inventory and reference diagram.

An outline of the basic steps which Historic New England must now follow to implement the Master Plan is as follows:

1. Carry out service and upgrade recommendations to steam heating system outlined in ACL Consulting report
2. Determine appropriate treatment for window openings
 - A. Repair existing wooden sash and replace missing windows with new wooden sash
 - B. Replace all windows with new aluminum sash in 6 over 6 configuration
3. Submit RFP, fund and implement window opening treatment and re-application of polymer coating to exterior of building with SHPO approval
4. Develop collections storage internal relocation plan prior to interior construction phases of project

5. Submit RFP, fund and implement secondary wall construction and epoxy coating of ceilings and floors for 5th floor collections storage space.
6. Submit RFP, fund and implement air-source heat pump, humidifier and ductwork installation on 5th floor
7. Monitor environment and evaluate energy and cost savings of 5th floor implementations
8. Proceed with implementation of project on subsequent floors as funding becomes available, including plans for a space with more tightly controlled RH on the fourth floor for glass-plate negative storage

Conclusions and Lessons Learned

The project to develop a master plan for environmental improvements and energy conservation in Historic New England's collections storage facility was very successful. A written master plan was developed by Building Science Corporation based on environmental data collected for several years by Historic New England, experiential evidence provided by on-site Historic New England Staff and information collected by Building Science Corporation on-site during several days of visits. The project proceeded on schedule and in a timely manner, with a minimum of disruption to the operations of the collections storage facility. The master plan submitted makes a series of branched recommendations, which depend on the expected lifetime of the existing boiler, and the level of expenditure that Historic New England would be able to support. One particular path, based on a balance of initial cost outlay versus increase in energy efficiency and environmental stabilization is most recommended in the master plan.

The primary unexpected outcome, and therefore lesson learned from the project involves water infiltration to the building. At the outset of the project, water infiltration was considered to be simply one of the various environmental condition problems facing the collections storage facility. Building Science Corporation's evaluation of the building, however, identified it as the issue that must be addressed first, before all others. All subsequent recommendations in the building master plan will require that the water infiltration be effectively eliminated, or their effectiveness would be compromised. Moreover, for water infiltration to be eliminated, *all* the window openings in the building will have to be addressed. This will require a very high initial cost outlay, before any efforts to stabilize the temperature and relative humidity can be implemented. Any treatment of the window openings will also have to be in keeping with Historic New England's mission as a preservation organization and the building's status as part of an historic district. Consultation with the Massachusetts SHPO will be necessary, an additional aspect of any implementation which, while not onerous, was not part of the initial conception.

Despite this unexpected aspect of the master plan, it provides an excellent framework for planning, budgeting, and fundraising for a series of changes to Historic New England's collections storage facility, which will improve both its energy efficiency, and its level of environmental control in the collections storage areas. These storage areas will eventually allow Historic New England, as well as other institutions using storage space in the facility, to better preserve their collections in an environmentally friendly way. Historic New England will be better able to fulfill its mission and strategic goals.